

# **Intelligent Compaction Design Guidance July 8, 2015**

## ***Introduction***

Compaction is one of the most important processes in roadway construction. Pavement materials must be compacted to optimum densities to ensure adequate support, stability, and strength—achieving these densities uniformly is the key to long lasting roadway performance. Current procedures using conventional compaction equipment and spot location density testing may result in inadequate and/or non-uniform material densities. Inadequate compaction is one of the major factors in premature pavement failure.

Intelligent compaction rollers facilitate real-time quality control for compaction by monitoring roller passes, surface temperature and material stiffness that allow for timely adjustments to the compaction process. Intelligent compaction rollers maintain a continuous data record of precise location of the roller using GPS, the number of roller passes, and material stiffness measurements. The data can be processed using FHWA sponsored Veta software to create a daily compaction quality control report to ensure that specification required roller passes, material temperature and material stiffness based on material density are met.

## ***Project Selection***

Intelligent compaction is a new technology that requires rollers have additional equipment, precision location using GPS, contractor having full-time quality control technician and just in time training for contractor and Caltrans staff. At this time, based on the additional cost involved in using intelligent compaction it is recommended that intelligent compaction be used on projects that meet the following criteria.

For HMA, including RHMA and OGFC, use intelligent compaction for projects that meet the following criteria:

- 1- Minimum 5000 tons of HMA excluding any HMA for leveling course and replace asphalt concrete surfacing.
- 2- Paving areas must be of sufficient size where normal compaction equipment may be used.
- 3- Projects that are mostly continuous paving. Projects that have multiple locations or project where staging limits HMA paving to less than 1000 tons per location or day should not require the use of intelligent compaction.
- 4- HMA is compacted under method compaction or has density requirement.
- 5- Project location must be able to receive GPS signals, not obscured by steep terrain, heavy tree cover, or tall buildings.

For RHMA projects where the estimated minimum atmospheric temperature at time of placement is 45 degrees F include intelligent compaction. The minimum limit on tons of HMA does not apply to RHMA placed at low temperature.

District surveys unit may be consulted to determine GPS coverage for a project location. Minor loss of GPS coverage does not disqualify a project from using intelligent compaction since there are GPS technologies that compensate minor loss of coverage.

For cold in-place recycling (CIR) and full depth reclamation (FDR), use intelligent compaction specification for all projects.

### ***Specifications***

The following non-standard special provisions (NSSP) have been developed for intelligent compaction:

- 1- HMA – NSSP Section 39-8 of the standard specification
- 2- Cold in-place recycling (CIR)-NSSP 30-6
- 3- Full Depth Recycling - in progress
- 4- Soil and embankment – in progress

To obtain the most recent intelligent compaction non-standard special provisions or approval to use the non-standard special provisions contact Ebi Fini at [Ebi.Fini@dot.ca.gov](mailto:Ebi.Fini@dot.ca.gov).

Visit the department intelligent compaction webpage at [www.dot.ca.gov/hq/construc/ic](http://www.dot.ca.gov/hq/construc/ic) .

The intelligent compaction specifications do not change the specified compaction requirements for materials. Intelligent compaction non-standard special provisions address the equipment, operation, data management, data analysis, and compaction quality control reporting requirements.

In order for intelligent compaction to provide accurate data designers must provide information in the intelligent compaction specifications that will be used by contractors for setting up intelligent compaction rollers and for analyzing data using Veda software. Following are more details about the information required for editing the specifications:

**Project Plan Layout** - The contractor needs to create the project layout (alignment) using the available electronic design files in CAiCE(kcm), Civil 3D (dwg) or landxm. In absence of electronic files, the contractor may use the project plans or the as built plans to establish project layout. If the district is unable to provide any of the above, then it is the contractor responsibility to create the project layout of the existing pavement using contractor's GPS rover calibrated for the project site.

**California Coordinate System of 1983 (CCS83)** – Shown below is the California Coordinate System of 1983 zones.



CCS83 is a set of 6 geographic zone or coordinate systems designed for specific regions of the State of California. Find the zone corresponding to the project and insert it in the specification. Consult District Survey unit for questions on which zone to require for a project.

**Project Control Points** – In order for the contractor to do GPS rover and roller site calibrations, one survey control point per mile or a minimum of three survey control points are needed. Contact the district survey unit to determine if survey control points are available. Request that surveys provide a Project Control Map or Form 4.1 which identifies survey control points within the project limits that can then be used to create a Project Control Map. In absence of providing a Project Control Map in the project plans, provide the survey control points shown on Form 4.1 in project Supplemental Information handout.

If survey control points are not available prior to project advertisement then edit the specification so that survey control points will be provided when requested by the Contractor 15 days in advance of GPS site calibration. Inform the district survey unit that survey control points will be required during construction and establish surveys project support costs based on a minimum

estimate of \$5,000 for three points and \$1,000 for each additional survey control point for District Surveys to establish the project control points.

### **Specifications Editing Instructions**

**Hot Mix Asphalt (HMA)** – Edit the following paragraphs of the specification (based on NSSP D11-14-14) accordingly and include the required documents:

**Paragraph 5-** Use paragraph 5 if electronic project layout plans are available, insert the file format of the electronic design file (CAiCE, Civil 3D or landxm) when available. When paragraph 5 is used delete paragraphs 6, 7, and 8.

**Paragraph 6-** Use paragraph 6 if electronic design file is not available and project layout plans are available in the project plans. When paragraph 6 is used delete paragraphs 5, 7, and 8

**Paragraph 7-** Use paragraph 7 if electronic design files and project layout plans are not available. Ensure that as-built plans are available and you may provide them as Supplemental Project Information. When paragraph 7 is used delete paragraphs 5, 6, and 8.

**Paragraph 8-** Use paragraph 8 if electronic design files, project layout plans and as-built plans are not available. When paragraph 7 is used delete paragraphs 5, 6 and 7.

**Paragraph 55-** Insert **California Coordinate System of 1983 (CCS83)** for the project. Refer to chapter 4 of Survey Manual, find the **California Coordinate System of 1983 (CCS83)** zone based on the project location. Consult District Survey unit for questions about which zone to require for a project when a project limits include multiple zones.

**Paragraph 59-** Use paragraph 56 when project control map is available and is included in the project plans. When paragraph 59 is used delete paragraph 60 and 61.

**Paragraph 60-** Use paragraph 57 when a project control map is not available. When paragraph 57 is used delete paragraph 59 and 61.

**Paragraph 61-** Use paragraph 58 when a project control map and survey control points are not available prior to project advertisement. When paragraph 61 is used delete paragraph 59 and 60.

**Cold In-Place Recycling (CIR)** – Edit the following paragraphs of the specification (based on NSSP D10-17-14) accordingly and include the required documents:

**Paragraph 4-** Use paragraph 4 if electronic project layout plans are available, insert the file format of **electronic design file** (CAiCE, Civil 3D or landxm) when available. When paragraph 4 is used delete paragraphs 5, 6 and 7.

**Paragraph 5-** Use paragraph 5 if electronic design file is not available and project layout plans are available in the project plans. When paragraph 5 is used delete paragraphs 4, 6 and 7.

**Paragraph 6-** Use paragraph 6 if electronic design files and project layout plans are not available. Ensure that as-built plans are available and you may provide them as Supplemental Project Information. When paragraph 6 is used delete paragraphs 4, 5 and 7.

**Paragraph 7-** Use paragraph 7 if electronic design files, project layout plans and as-built plans are not available. When paragraph 7 is used delete paragraphs 4, 5 and 6.

**Paragraph 52-** Insert **California Coordinate System of 1983 (CCS83)** for the project. Refer to chapter 4 of Survey Manual, find the **California Coordinate System of 1983 (CCS83)** zone for project location and insert it. Consult District Survey unit for questions about which zone to require for a project when a project limits include multiple zones.

**Paragraph 56-** Use paragraph 56 when project control map is available and is included in the project plans. When paragraph 53 is used delete paragraph 56 and 57.

**Paragraph 57-** Use paragraph 57 when project control map is not available and survey control points are included in Supplemental project Information. When paragraph 57 is used delete paragraph 56 and 58.

**Paragraph 58-** Use paragraph 58 when a project control map and survey control points are not available prior to project advertisement. When paragraph 58 is used delete paragraph 56 and 57.

**Estimating Intelligent Compaction Cost**

**Hot Mix Asphalt (HMA)** - The estimated cost of intelligent compaction for HMA should be 1% to 3% of HMA estimated cost based on the current data. Recommend using 3% for less than 20,000 tons of HMA and 1% above 20,000 tons of HMA. This will change as more cost data for intelligent compaction becomes available. The intelligent compaction bid item number is 390030 and is paid as lump sum.

**Example-** The engineer estimates that there is 6,500 tons of Type A HMA bid item 390300. The cost of HMA is \$80 per ton for a total of \$520,000.00.

Intelligent Compaction Cost Estimate:

$$\$520,000.00 \times .03(3\%) = \$15,600.00$$

The cost of intelligent compaction will be \$2.40/ton of HMA.

The engineer's lump sum estimate for intelligent compaction should be \$15,600.00.

**Cold In-Place Recycling (CIR)**- The estimated cost of intelligent compaction for CIR should be 3% to 5% of the cost of all components of CIR including cold-in place recycling (SQYD), cement (Ton), emulsified recycling agent (Ton), Asphalt emulsion (Ton), and sand cover (Ton). Recommend using 5% for less than 200,000 sqyd of CIR and 3% for above 200,000 sqyd of CIR. This will change as more cost data for intelligent compaction becomes available. The intelligent compaction cold in-place recycling bid item is 306100A Intelligent Compaction (Cold In Place Recycling) LS.

**Example-**The engineer estimates for CIR is 160,000 sqyd at \$10/sqyd of CIR which requires 200 tons of cement at \$145/ton, 1000 tons of emulsified recycling agent at \$400/ton, 63 tons of asphalt emulsion at \$200/ton, and 250 tons of sand cover at \$15/ton. The total cost CIR including the materials is calculated as follows:

CIR

$$160,000 \text{ sqyd} \times \$10/\text{sqyd} = \$1,600,000.00$$

Cement

$$200 \text{ tons} \times \$145/\text{ton} = \$29,000.00$$

Emulsified Recycling Agent

$$1,000 \text{ tons} \times \$400/\text{ton} = \$400,000$$

Asphalt Emulsion

$$63 \text{ tons} \times \$200/\text{ton} = \$12,600$$

Sand

$$250 \text{ tons} \times \$15/\text{ton} = \$3,750$$

Total Cost for CIR

$$\$2,045,350.00$$

Intelligent Compaction Cost Estimate:

$$\$2,045,350.00 \times .05(5\%) = \$102,267.00$$

The engineer's lump sum estimate for intelligent compaction should be \$102,267.00.

***Additional Information***

FHWA is encouraging state DOTs to implement intelligent compaction as part of the second round of Every Day Counts program. Caltrans is a lead State for intelligent compaction deployment. Caltrans is implementing intelligent compaction in California under the Every Day Counts program by pilot projects during 2014-2015 and expects full implementation by 2016. For more detailed information about intelligent compaction, visit [Caltrans Intelligent Compaction webpage](#)

For questions about the intelligent compaction specifications and cost estimating contact Ebi Fini at 916-227-5396 ,[Ebi.Fini@dot.ca.gov](mailto:Ebi.Fini@dot.ca.gov) or Chuck Suszko at [Chuck.Suszko@dot.ca.gov](mailto:Chuck.Suszko@dot.ca.gov).